Essentials of ICT
ICT1113

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Lecture 04_Part II
Output and Storage Devices

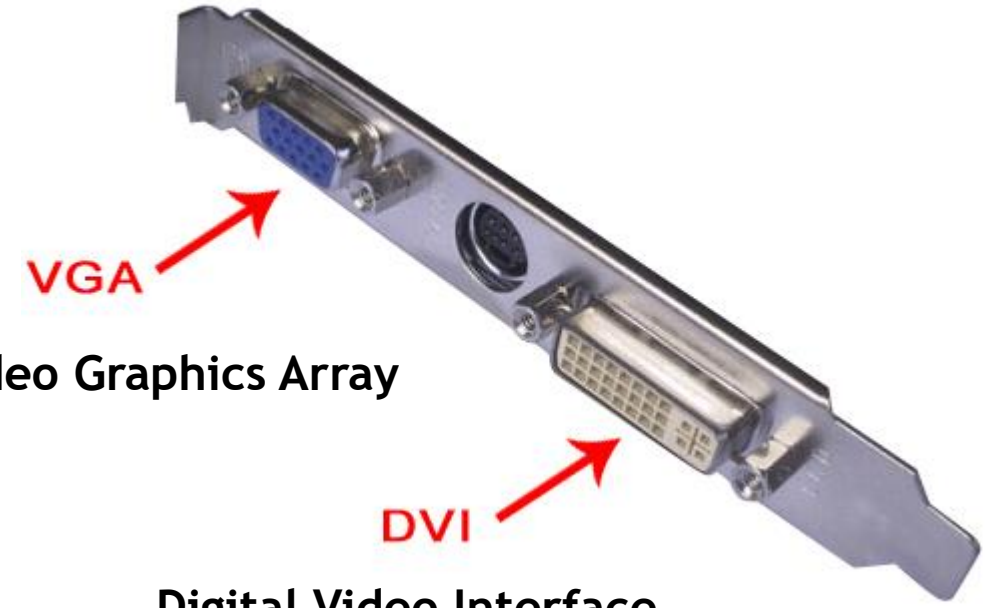
Output Devices

- **Communicate the results of data processing to the outside world**
  - Monitors
    - CRT
    - Flat-Panel
  - Multimedia projectors
  - Sound systems
  - Printers
    - Dot matrix
    - Ink Jet
    - Laser Jet

Monitors

- **Primary output device** of a computer system
- Provide a **graphical representation** of information on the screen
- Comprises the display device, circuitry, and an enclosure
- Two types of monitors are common
  - CRT monitors
  - Flat-Panel (TFT-LCD , OLED, Plasma)
- monitor **Connections**
  - Video Graphics Array (VGA) connector
  - Digital Visual Interface (DVI)

Connections



Video Graphics Array

Digital Video Interface

A male DVI-D (single link) connector

Monitor connections

VGA cable : three-row 15-pin DE-15 connector

HDMI Connector.

High-Definition Multimedia Interface

Key Features

- **Size of the viewing area** - usually stated in inches diagonally 7,10,11,14,15,17,19…..45
- **Resolution** - top to bottom
- Image **contrast-**
- Image **brightness** /Luminance-
- **Power consumption**
- **Refresh rates** -
- **Dot pitch**
- **Price**

Multimedia Projectors

- Usually limited to conference halls, board rooms and other training facilities
- There are two types of technologies used for multimedia projectors

Liquid crystal display (LCD)

- work by using liquid crystal panels, a lamp, a prism, mirrors
- images are not sharp but blur: therefore require a dark room
- require a considerable time to cool down
- low cost

Digital light processing (DLP)

- has special microchip called the Digital Micro-mirror device
- images are sharp not blur and brighter
- can be used to project images on normal light conditions
- compact and small in size
- take very little time to cool down
- expensive

Sound Systems

- Sound card and speakers have become a standard component in a computer system
- **Sound system**
  - started by having one or two speakers
  - one sub-woofer and two speakers (2.1 system) , 7.1 system
- **Headphones**
  - Clarity , maintain silence of the surroundings
- **Standard audio connection**
  - 3.5 mm stereo jack plug often color-coded lime green for computer sound cards
- **MIDI (Musical Instrument Digital Interface) connectors**
  - most electronic musical instruments can be directly connected to sound cards

Printers

- Produce hard copy output on physical print media
- Categorized into two types
  - Impact
    - Printing occurs **by pressing an inked ribbon** against the paper
  - Non-impact
    - **No** components that **touch** the paper, but **ink/toner is sprayed** on to the paper and then **thermally bonded**
- Attached to a computer
  - RS-232,EIA-422, Parallel, FireWire or USB cable or wireless
- Dot matrix, Ink Jet, Laser Jet

Key Features

- **Image quality** - dots per inch (dpi), how clear and sharp your printed image will be
  - 300 dpi - adequate for text and low resolution images and drawings
  - 600 dpi - adequate quality for medium quality images
  - 1200 dpi and above - High quality professional prints
- **Speed** : this has two factors
  - Time for first page - the time it take for the printer to print the first page once the print command is received by the printer
  - Papers per minute (ppm) - the number of printouts per minute
    - two values, One for text and the other for graphics since graphic take a longer time
- **Initial cost** - The initial investment for the printer
- **Operation cost** - The cost of ink or toner cartridges and maintenance cost

Storage Devices

Storage Devices

- Store programs or data → temporary or permanent basis
- computers represent information in binary code
  - sequences of 0s and 1s
  - each bit may be stored by any physical system that can be in either of two stable states, to represent 0 and 1: bi-stable system
- bistable systems
  - switch :could be an on-off
  - electrical capacitor: can store or lose a charge

  } tiny electrical switches

  - magnet: polarity up or down ⟶ disks or tape with a magnetic coating
  - surface: have a pit or not ⟶ discs with patterns of pits

Key characteristics

- Memory systems are classified according to their key characteristics

Location
- Internal (e.g. processor registers, main memory, cache)
- External (e.g. optical disks, magnetic disks, tapes)

Capacity
- Number of words
- Number of bytes

Unit of Transfer
- Word
- Block

Access Method
- Sequential
- Direct
- Random
- Associative

Performance
- Access time
- Cycle time
- Transfer rate

Physical Type
- Semiconductor
- Magnetic
- Optical
- Magneto-optical

Physical Characteristics
- Volatile/nonvolatile
- Erasable/nonerasable

Organization
- Memory modules

Location

- Two main categories according to the location
- **Internal (directly accessible by the processor)**
  - memory internal to the computer : internal memory
  - often referred to simply as memory
  - registers, cache and the main memory
- **External (accessible by the processor via an I/O module)**
  - not directly accessible by the CPU
  - peripheral storage devices
  - disk and tape

Access Method (method of accessing units of data)

- **Sequential Access**
  - Memory is organized into **units of data**, called **records**
  - Access must be made in a specific linear sequence
  - Must be moved from its current location to the desired location by passing and rejecting each intermediate record
  - Access time is highly variable

  Ex:Tape
- **Random Access**
  - The time to access a given location is independent of the sequence of prior access and is constant

  Ex: Main memory, Cache

Physical Type

- **Semiconductor memory (RAM, cache, register, flash)**

  implemented on a semiconductor-based integrated circuit

  contain millions of tiny transistors or capacitors

- **Magnetic surface memory (floppy , Hard disk, Magnetic tape)**

  Uses different patterns of magnetization on a magnetically coated surface to store information ,access using one or more read/write heads

- **Optical (CD,VCD,DVD)**

  Stores information in deformities on the surface of a circular disc and reads this information by illuminating the surface with a laser diode and observing the reflection

Capacity

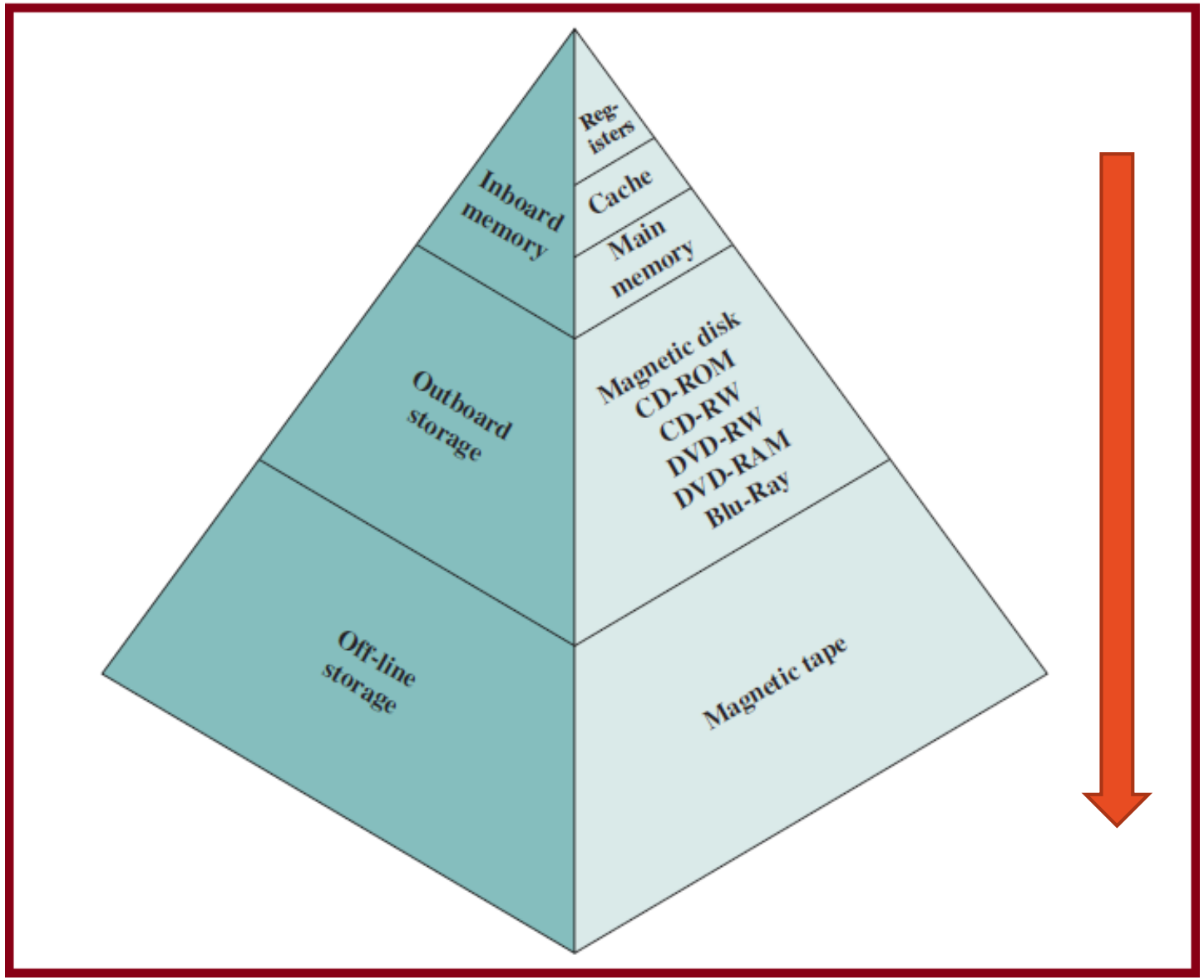
- Total **amount of stored information that** a storage device or medium **can hold**
- Expressed as a quantity of bits or bytes
  - 1byte= 8 bits or words
  - Common word lengths are 8,16,32 and 64 bits

Unit	Approx. Value (bytes)	Actual Value (bytes)
Kilobyte (KB)	1,000	1,024
Megabyte (MB)	1,000,000	1,048,576
Gigabyte (GB)	1,000,000,000	1,073,741,824
Terabyte (TB)	1,000,000,000,000	1,099,511,627,776

Memory Hierarchy

- No single technology is capable of satisfying the memory requirements of a computer system.
- Therefore, the typical computer system is equipped with a hierarchy of memory sub systems.
- Memory hierarchy structured from levels of memory differing in speed and size
  - –The faster memory, the more expensive, tends to be smaller
  - –The further level from processor the more time it takes to access it

Memory Hierarchy - Diagram



- Decreasing cost per bit
- Increasing capacity
- Increasing access time(Decreasing speed)

Registers

- Registers are at the top of the memory hierarchy
- Fastest way for a CPU to access data
  - contents can be accessed more quickly than storage available elsewhere
- Small amount of storage available on the CPU
  - data is loaded from some larger memory into registers
  - manipulated or tested in some way (arithmetic/logic/comparison)
  - then stored back into memory, possibly at some different location

- Registers are classified as follows:
  (according to their **content** or **instructions** that operate on them)

  - **Data registers :** used to hold numeric values
    such as integer and floating-point values

  - **Address registers :** hold addresses
    used by instructions that indirectly access memory

  - **General purpose registers:** store both data and addresses
    i.e., they are combined Data/Address registers

  - **Special purpose registers:** hold program state
    they usually include the program counter ,stack pointer, and status register

  - **Instruction registers :** store the instruction currently being executed

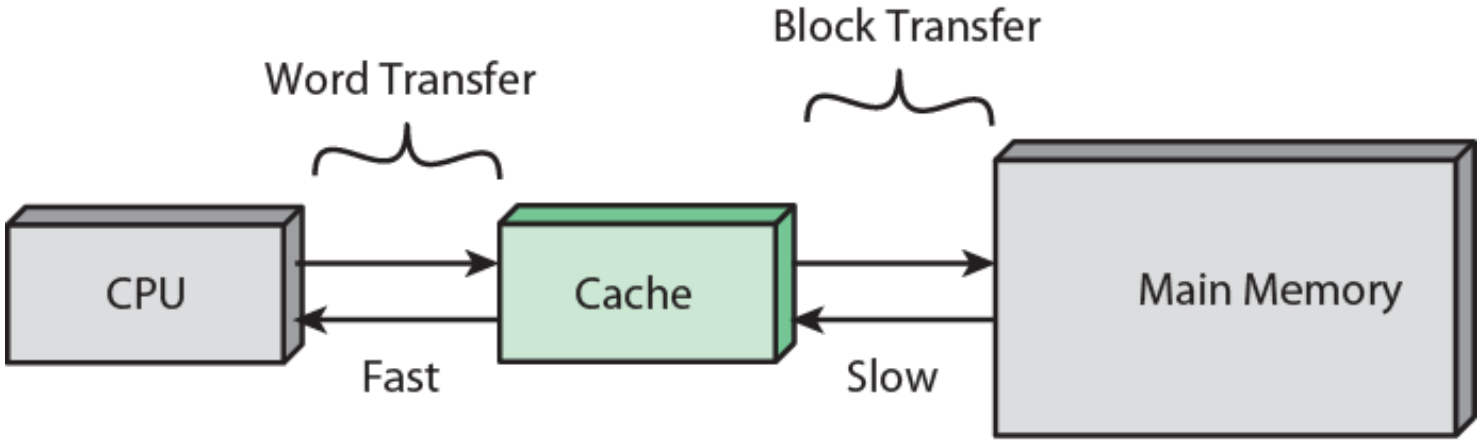
Cache

- Small amount of fast memory (can speed up CPU)
- Sits between main memory and CPU
- **Advantages**
  - Faster than main memory
  - Consumes less access time as compared to main memory
  - Stores programs that can be executed within a short period of time.
- **Disadvantages**
  - Limited capacity
  - Very expensive

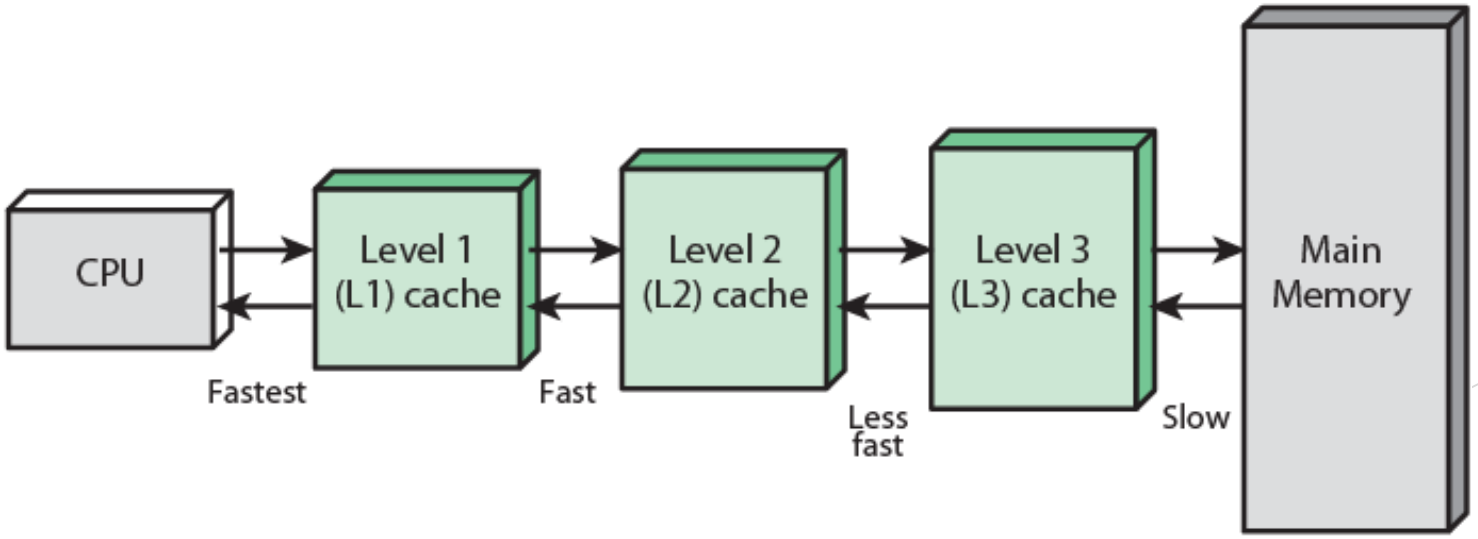
Locality of Reference

- **Most future accesses to main memory by the processor will be to locations which are recently accessed.**
- Cache automatically retains a copy of the recently used words from the main memory(DRAM)
  - ***Temporal locality***: recently accessed items are likely to be accessed in the near future
  - ***Spatial locality***: next access is often very close to our last access.
- **Hit -** If the accessed word is found in the faster memory
- **Miss -** If the accessed word is not found in the faster memory

Cache and Main Memory



(a) Single cache



(b) Three-level cache organization

Main Memory

- RAM
  - Random Access Memory
  - Connected to the central processing unit via a *memory bus*
  - Volatile
  - Form of Integrated circuit
- Basically there are two different types of RAM
  - **DRAM :- Dynamic** Random Access Memory
  - **SRAM:- Static** Random Access Memory

- The two types differ in the technology they use to hold data

- DRAM
  - Store each bit of data in a separate capacitor
  - Less expensive
  - Slower
  - Simpler construction
  - Charges leak , Need refreshing even when powered
  - Main memory
  - Size – 1GB – 2GB

- SRAM
  - Store a bit of data in state of a flip-flop/latch
  - More expensive
  - Faster
  - More complex construction
  - No charges to leak, No refreshing needed when powered
  - Cache memory
  - Size – 1MB – 16MB

ROM

- Data stored in ROM cannot be modified (at least not very quickly or easily)
- modern types such as;
  - **Programmable read-only memory (PROM)**

    can be written to or programmed via a special device called a PROM programmer ,can only be programmed once
  - **Erasable programmable read-only memory (EPROM)**

    can be erased by exposure to strong ultraviolet light, rewritten process requires higher voltage

    EEPROM - Electrically erasable programmable read-only memory

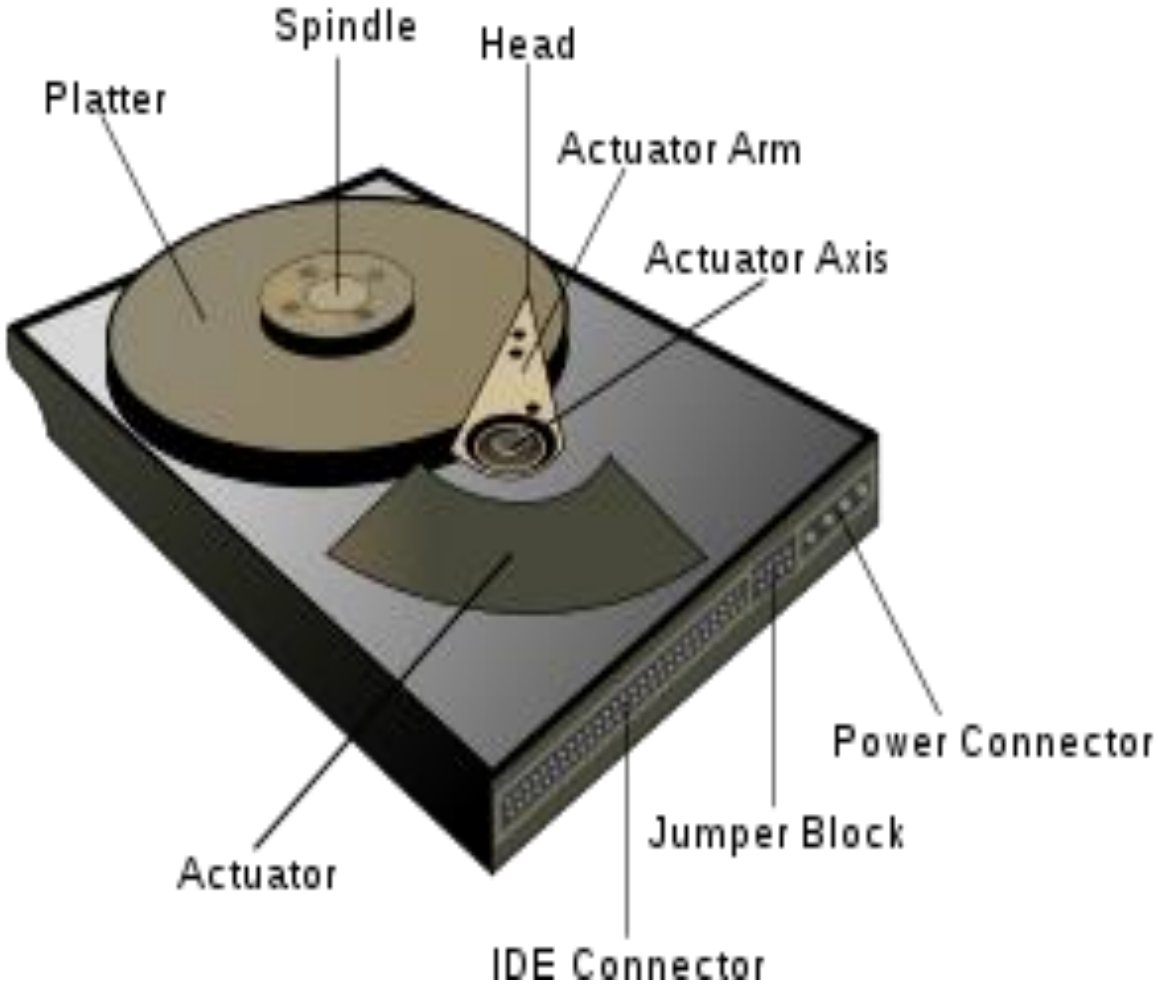
    electrically erased, then rewritten electrically

BIOS ROM

- Basic Input Output System – startup program
- First code run by computer when powered on (boot firmware)
- Load basic drivers from chip to the main memory
- POST -Power On Self Test
  - test of the basic components of the system
- Start the operating system
- Work as a layer between the hardware and the operating system
- In BIOS UI user can,
  - Configure hardware, Set the system clock, Enable or disable system components, Select potential boot devices, Set various password prompts
- Most modern BIOS chips are EEPROMs
  - BIOS upgrade

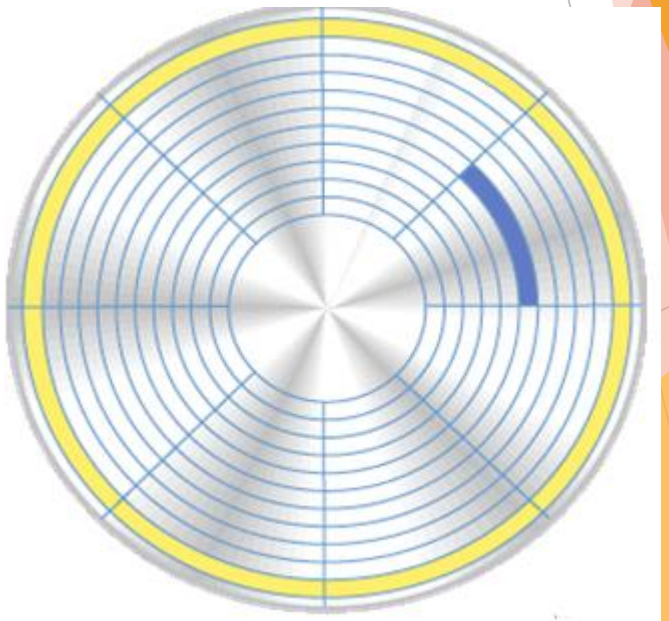
Hard Disk

- Non-volatile
- Random access device
- Data is read and written on the platter by read/write heads
- Spindle holds one or more flat circular disks called platters
- Stores data on platters with magnetic surfaces
  - different patterns of magnetization on a magnetically coated surface
  - sectors and tracks



a computer hard disk drive

tracks and sectors



Tertiary storage /tertiary memory

- Provides a third level of storage
- Involves a robotic mechanism which will *mount* (insert) and *dismount* removable mass storage media into a storage device according to the system's demands
- data is often copied to secondary storage before use
- used for archival of rarely accessed information
- much slower than secondary storage
- useful for extraordinarily large data stores, accessed without human operators

ex: tape libraries and optical jukeboxes

Taking backups

- Process of making copies of data
- These additional copies may be used to *restore* the original after a data loss event
- Data loss events
  - Hard drive failure
  - Overwriting a file by mistake
  - Formatting your hard disk by mistake
  - Destruction or corruption of data by malicious programs
  - Power fluctuation
  - disaster : fire, floods, lightning strikes and theft
- How often do I need to take backups? Depends on the
  - amount of data, value of data, amount of work done to produce data

Backup Data

What data ?

- Files which are **unique** and **can not be easily found** from another source like:
  - Office files (document files, spreadsheet files, presentation files)
  - image, audio and video files you have purchased or developed yourself
  - Databases
  - Address book
  - Scheduler, Planer and Bank and Financial records
  - Bookmarks of your web browser
  - Software you have purchased (installation files and the serial numbers)
  - Personal projects (Books, software, designs)
  - Other important files

Backup Medium

- Magnetic tape
  - most commonly used medium for bulk data storage
- Hard disk
  - External disks can be connected via local interfaces or via longer distance technologies
- Optical storage
- Floppy disk
  - many personal/home computer users **:obsolete choice**
- Remote backup service
  - Backing up via the internet to a remote location
  - can protect against some worst-case scenarios such as fires, floods, or earthquakes

Questions ???