

Secondary Storage

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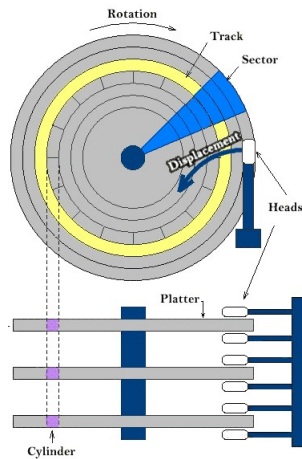
- Secondary storage include:
 - **Magnetic disks:**
 - Example: Hard disks
 - Used in personal computers
 - **Redundant Array of Independent Disks (RAID):**
 - Uses disk arrays to achieve greater performance and higher availability
 - Multiple disks are used as a parallel array of data storage devices built with redundancy to compensate for disk failures
 - Used in servers and large systems
 - **Optical disks:**
 - Uses optical storage technology
 - Examples: CDROM and DVD

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Magnetic Disks

- A **disk** is a circular platter constructed of nanomagnetic material, called **substrate**
- Usually both the sides are coated with a **magnetisable material**

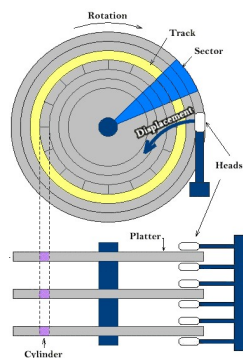


- Data are recorded on and retrieved from the disk via a conducting coil called **head**
- **Read/write head**
- Each head consists of a **magnetic yoke** and **magnetisable coil**
- Floppy disk
- Winchester disk (Hard disk)

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Read and Write Mechanism

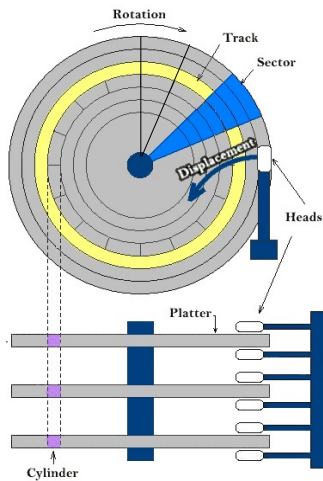


- **Write mechanism**
 - Electricity flowing through the coil (head) produces magnetic field
 - This induced magnetic field **magnetises the small area** of the recording medium
 - Different patterns of positive and negative current indicates 1 and 0
- **Read mechanism**
 - It exploits the fact that magnetic field moving relative to a coil produces an electric current in the coil (head)
 - When the surface of the disk passes under the head, it **generates a current of the same polarity** as the one already recorded

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Data Organization on the Disk



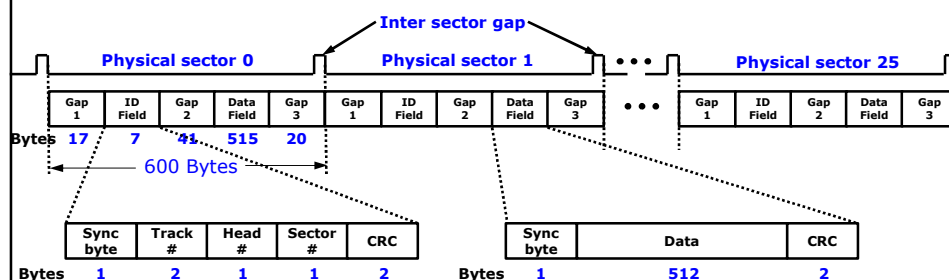
- **Track:**
 - Concentric set of rings on the platter
 - Each track is of the same width as head
- **Sector:**
 - The tracks are divided into hundreds of sectors per track
 - Each sector stores 512 bytes of information
- **Cylinder:**
 - The set of **all the tracks in the same relative position** on the platters

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Winchester Disk Format

- Some means needed to **locate sector positions within a track** – identifying start and end of each sector
- This is handled using **control data** recorded on the disk
- **Formatted disk**
 - Some **extra data (control data)** used only by the disk controller
 - Operating system does the formatting of disk
- **Each sector holds 512 bytes of data and control information**

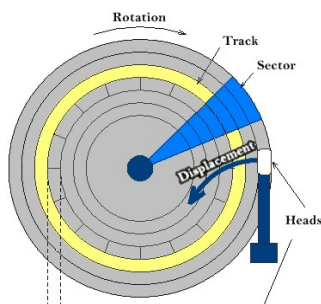


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Disk Performance Parameters

- When the disk drive is operating, the **disk is rotating at a constant speed**
- During read or write operation, the head must be positioned at **the desired track** and **at the beginning of the desired sector on that track**



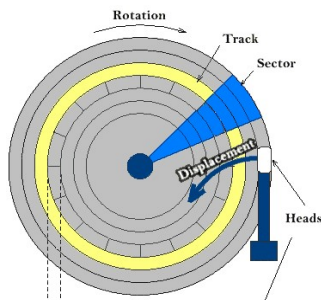
- **Seek time (T_s):**
 - Time required to move or position the head to the required track
 - It depends on where is the initial position
 - We consider **average seek time**
- **Track-to-track seek time:**
 - Time to move the head from one track to an adjacent track

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Disk Performance Parameters

- **Rotational delay or Rotational latency (T_r):**
 - Time taken for the beginning of the sector to read by the head
 - **Average time needed for the required sector to pass under the head** once the head has positioned at the correct track
 - Let r is the rotation speed measured in **revolutions per sec**



$$T_r = \frac{1}{2r}$$

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Disk Performance Parameters

- **Transfer time (T):**
 - Time taken to transfer b bytes of data to or from a track of the disk
 - b : Number of bytes to be transferred
 - r : Rotational speed
 - N : Number of bytes on the track

$$T = \frac{b}{rN}$$

- **Average access time (T_a):**
 - Total time to access the data
 - Sum of the average seek time, rotational delay and transfer time

$$T_a = T_s + T_r + T$$

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Hard Disk Parameter

- **Example: Segate Barracuda ES.2**
 - Capacity : 1TB
 - Track-to-track seek time : 0.8 ms
 - Average seek time : 8.5 ms
 - Spindle speed : 7200 rpm
 - Average rotational delay : 4.16 ms
 - Maximum transfer rate : 3GB/sec
 - Bytes per sector : 512
 - Tracks per cylinder : 8 (4 platters)

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